

Cereal Straw for Fiber

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Potential Areas of Concern

- Straw Supply and Price Relative to Paper Needs
- Straw Quality vs. Paper Products
- Special Pulp and Paper/Straw Processing Needs

Annual Washington State Wheat Straw Production

- 2 million acres per year
- 4 million tons of straw

Annual Washington State Burning of Cereal Straw

- 200,000 + acres/ year
- 45,000 + Tons of particulates, carbon monoxide, dioxide, and volatile carbon compounds
 - carbon credit possibilities

Pacific Northwest Pulp and Paper Raw Material Supply

- Existing Production Capacity Satisfied by Wood and Recycle Paper
- Opportunity for Non-woods depends on the \$\$\$ for wood and recycled paper
- Nonwood will compete in Corrugated Medium, Newsprint, Communication Grade
- There is so much straw nationally that some utilization must eventually happen

Annual Washington Timber Harvest

- 1×10^9 cubic ft. per year
- 1/3 is used to manufacture pulp and paper
- This is equivalent to a harvest of about 6500 acres per year of 50 year old Douglas Fir

Example of Straw Substitution in Pulp and Paper

- Substitute 15% straw in 600,000 tons per year of Pacific Northwest corrugated medium. It will consume 90,000 tons per year of straw. About 3% of the annual Washington Straw production

Technical Barriers

- Straw Harvest, Storage, Transportation, and **Preprocessing** for Pulp and Paper Production
- Control of Silica and Fine Material in Straw Raw Material
- Straw Pulp Bleaching
- Prove to the Industry that straw is acceptable for Corrugated Medium, Linerboard, Newsprint

Near Term Conventional Opportunities

- NSSC pulping at Boise Wallula
 - No silica or bleaching problems
- TMP pulping at Usk, and Millwood
 - no silica issue/ bleaching an issue
- Fully bleached Chemimechanical at Deink Plant at Wallula
 - No silica issue/bleaching an issue
- Linerboard Production at Missoula
 - Silica problem/no bleaching

Near Term Non-Conventional

- Molded Pulp Products at Wenatchee and Yakima
 - Interested companies
 - high cost raw material
 - No silica and no bleaching issue

New Pulping Developments

- Universal Pulping
 - Caustic/Nitric Acid/Alum (atmospheric)
- Caustic/Peroxide
- KOH/Peroxide
- Modified Universal Pulping
 - KOH/Nitric/Alum

Straw Consumption for Ponderosa Fibers/ Columbia River LLC

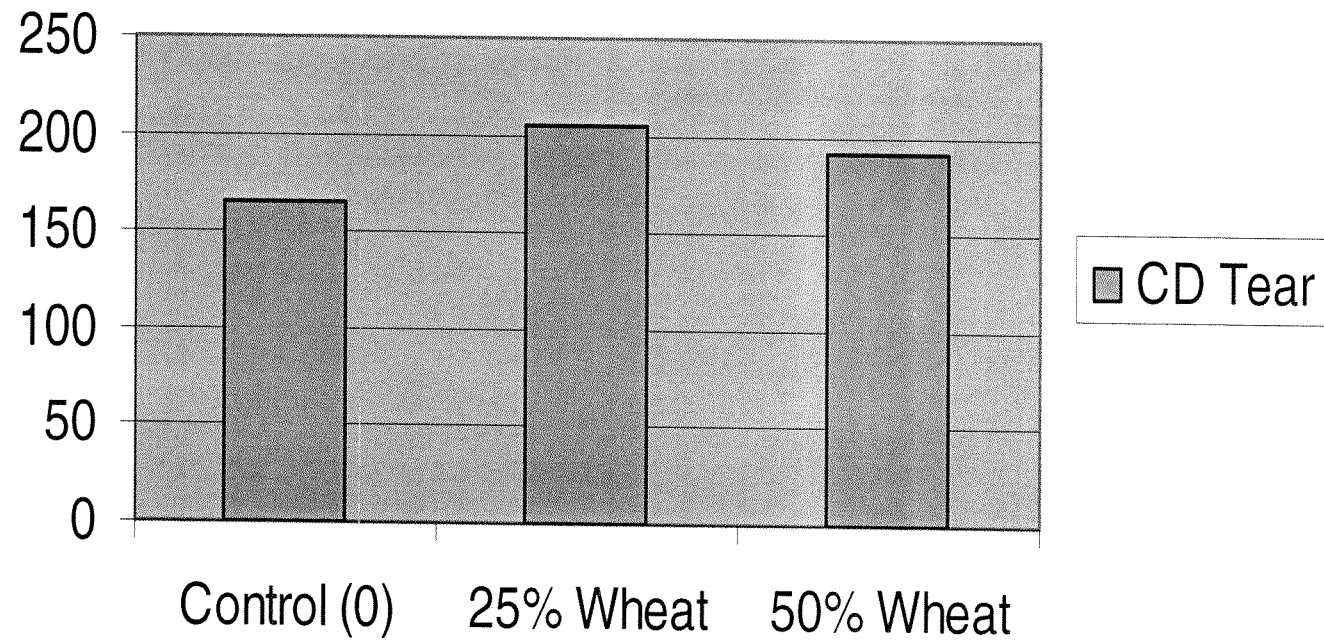
- 200 Ton per Day bleached pulp
 - 140,000 tons of straw
- 300 Ton per Day brown stock
 - 210,000 tons of straw per year

<u>City</u>	<u>Company</u>	<u>PMS</u>	<u>Grade</u>	<u>Tons</u>	<u>Straw</u>	<u>% Sub</u>
Bellingham	Georgia Pac	5	Tissue	260	1, 2	to 20
Camas	Georgia Pac	10	Various	1500	1, 2	to 25
Cosmopolis	Weyerhaeuser	1	Mkt Pulp	400		
Longview	Weyerhaeuser	3	Copy	400	2	to 20
	Weyerhaeuser		Liquid Packaging	800	1	to 10
	Longview Fibre	12	Various Brown	3500	1 3	to 40
	Norpac	3	Newsprint	2000	1, 2	to 25
Everett	Kimberly-Clark	5	Tissue	580	1,2	to 20
Hoquiam	Grays Harbor	2	Fine	400	1, 2	to 20
Pt. Angeles	Daishowa	2	Directory	550	1, 2	to 25
Pt. Townsend	Pt. Townsend	1	Linerboard/Bag	400	1, 2	to 40
Inland Empire	Spokane	1	Newsprint	550	1, 2	to 25
Sonoco Products	Sumner	1	Chipboard	125	1, 2, 3	to 40
Simpson	Tacoma	2	Linerboard/Bag	850	1, 2	to 40
Carastar	Tacoma	1	Tube/Core	150	1, 2 , 3	to 40
Ponderay Newsprint	Usk	1	Newsprint	720	1, 2	to 25
Boise Cascade	Wallula	1	Medium	350	1, 2	to 40
		1	Copy	450	1, 2	to 20
			Mkt Pulp	550		
Wenatchee	Keyes Fiber	1	Molded	80	1, 2, 3	to 50
Yakima	Michelsen	1	Molded	40	1, 2, 3	to 50
	1	wheat				
	2	seed alfalfa				
	3	blue grass				

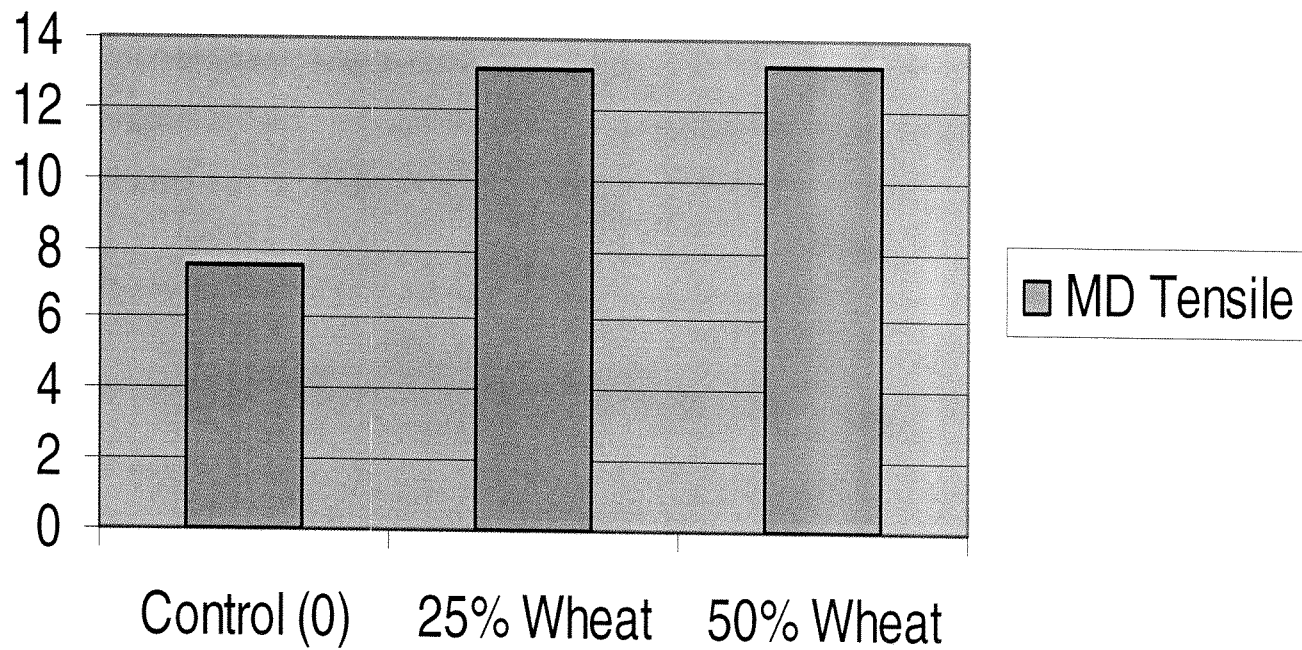
Medium Manufacture

137 gram per square meter

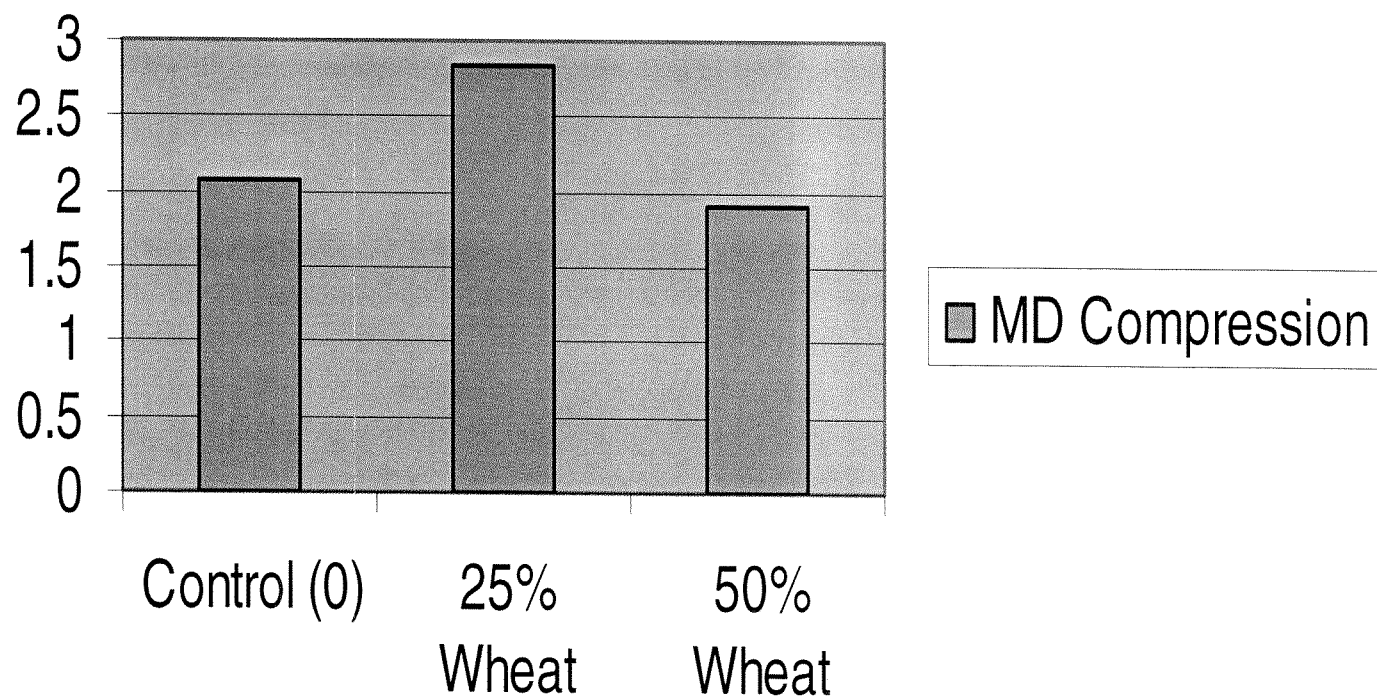
CD Tear (grams/single sheet)



MD Tensile (kgs/inch)



MD Compression (N/m)



Bleaching Developments

- Need for Totally Chlorine Free (TCF)
- Traditional Peroxide Bleaching
- Explore other possibilities
 - Peracetic Acid Pretreatments
 - Peracetic Acid Bleaching

<u>Straw Type</u>	<u>Peracetic Acid</u>	<u>Peroxide</u>	<u>Peracetic Acid</u>	<u>Brightness</u>
Wheat	0.5	5	1	53.7
	1	3	0.5	57.3
	2	3	0.5	65.4
Blue Grass	0.5	5	1	47.2
	1	3	0.5	48.7
	2	3	0.5	51.6
Alfalfa	0.5	5	1	54.3
	1	3	0.5	59.7
	2	3	0.5	67.9
Wheat	2	5	1	74.2

Field Application

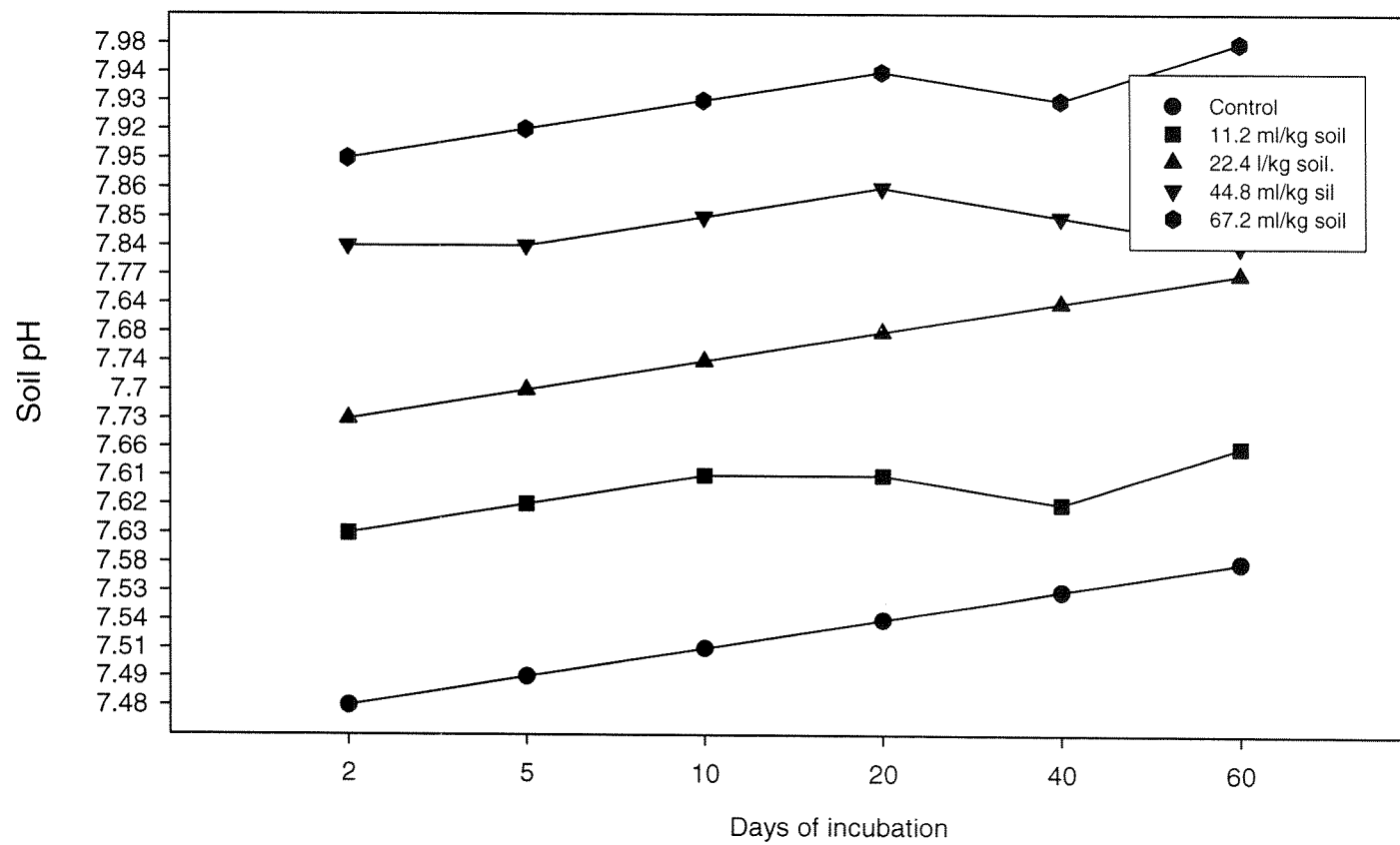


Fig. 1 Soil pH as influenced by black liquor application rates

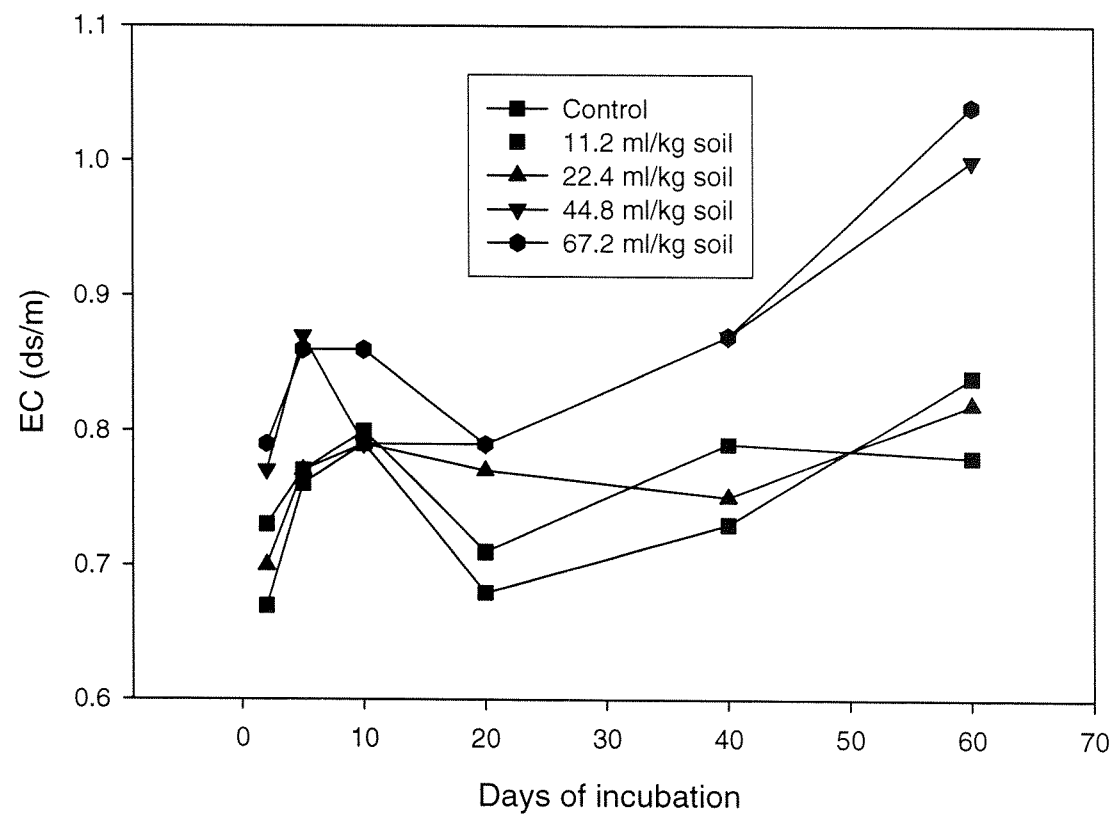


Fig. 2 Soil electrical conductivity as influenced by black liquor application rates

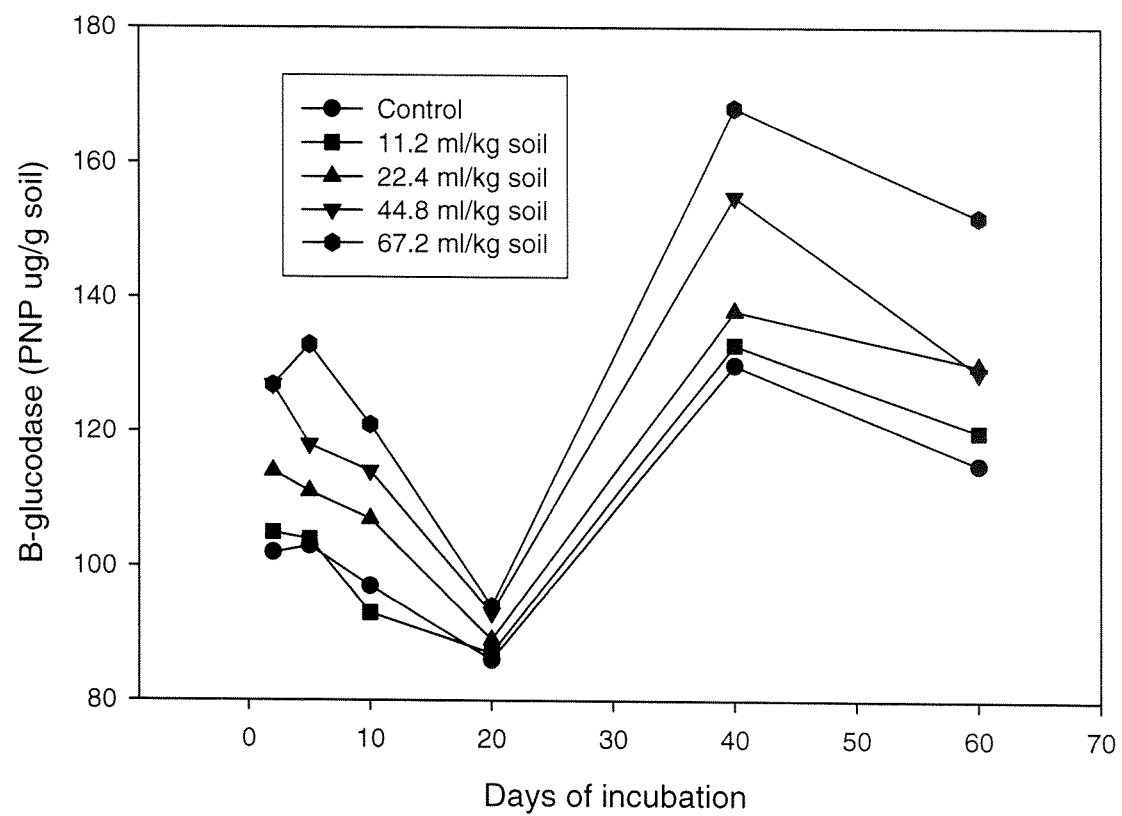


Fig. 3 B-glucodase activity as influenced by black liquor application rates

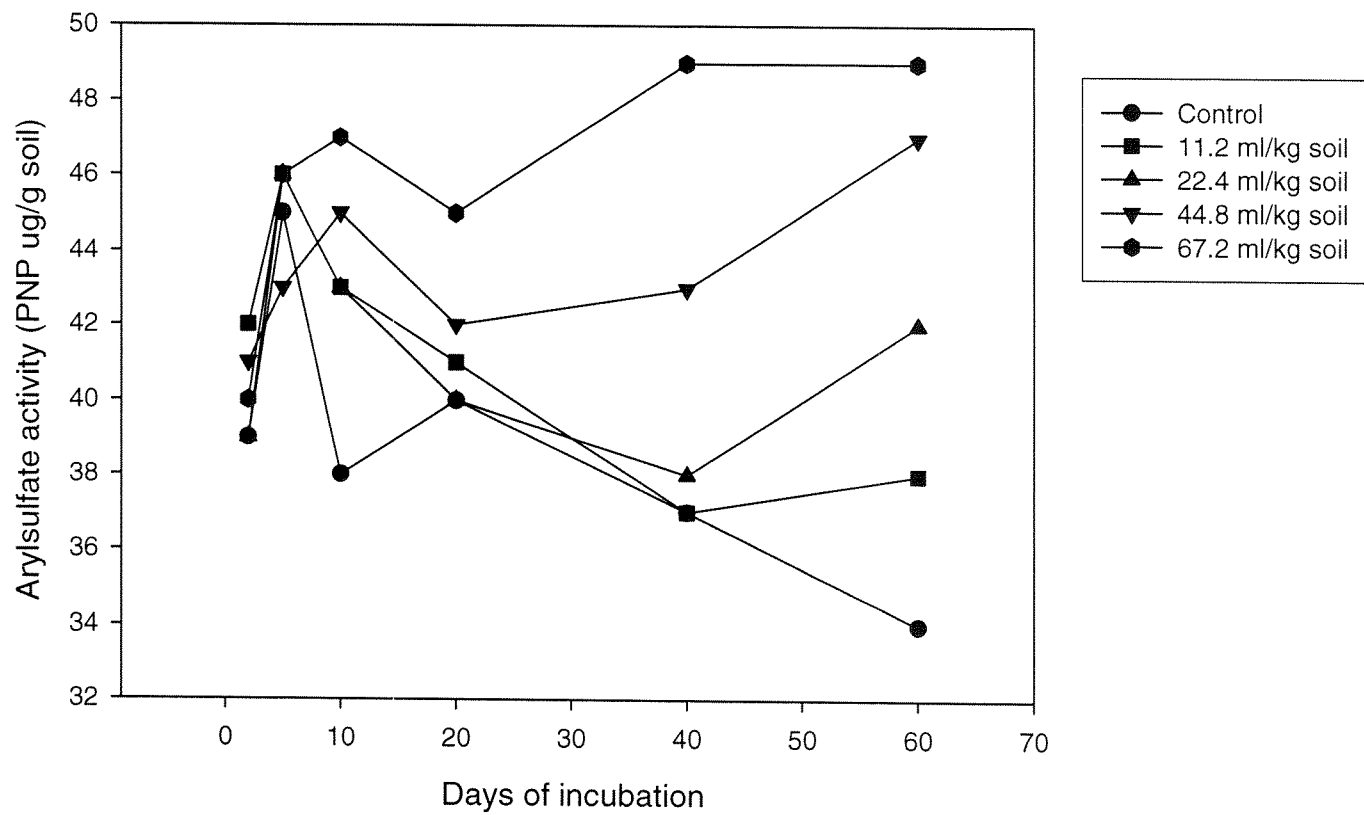


Fig. 5 Soil Arylsulfate activity as influenced by black liquor application rates

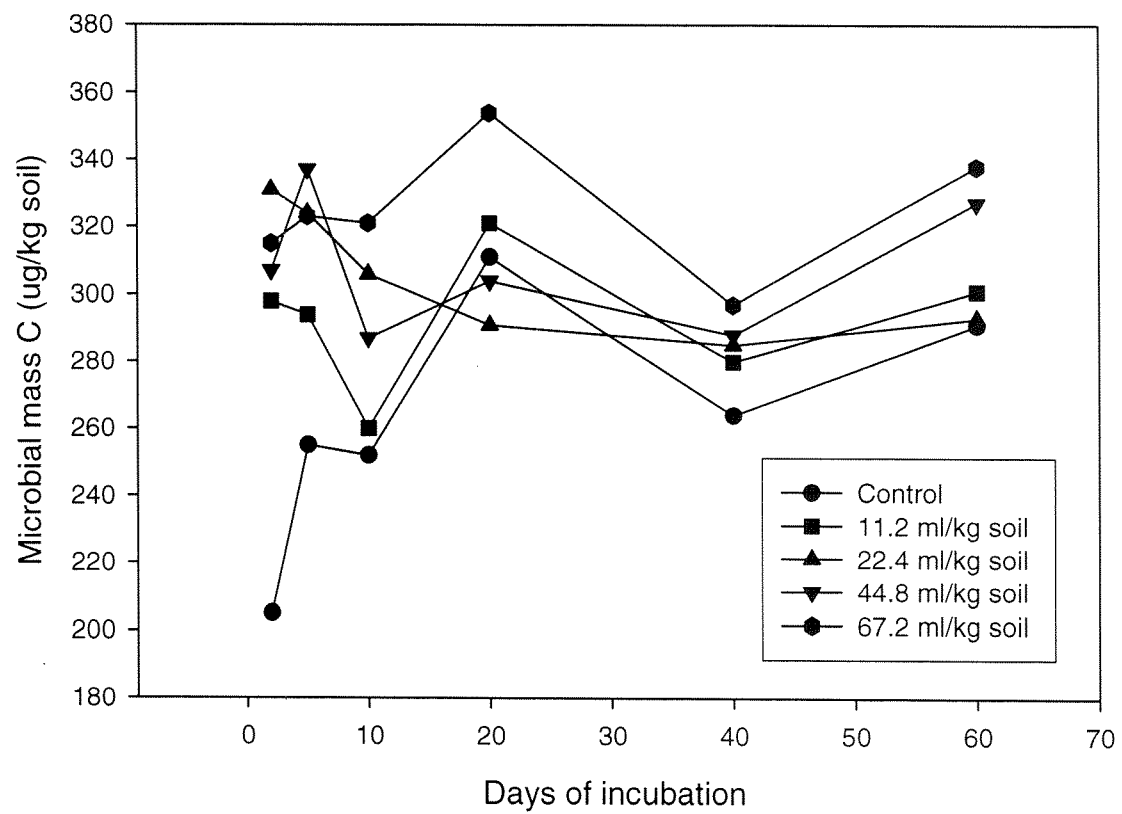


Fig. 6 Soil microbial mass C as influenced by black liquor application rates

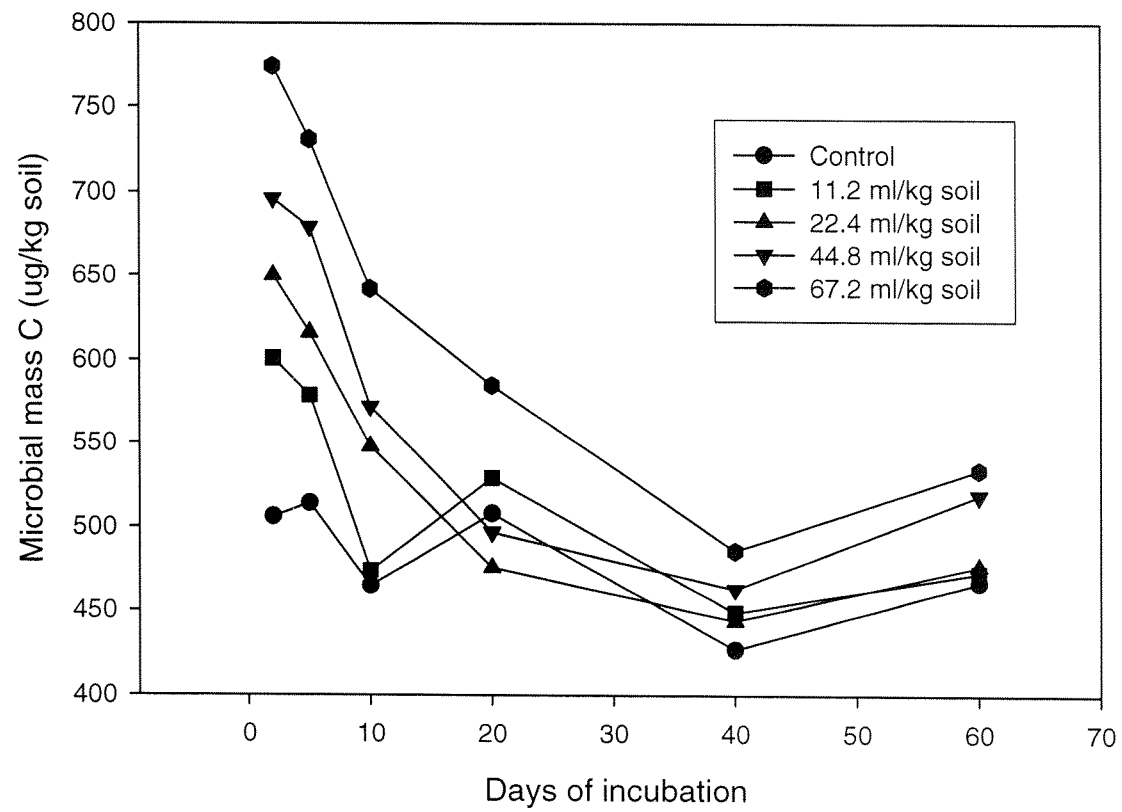


Fig. 7 Soil microbial C as influenced by black liquor application rates

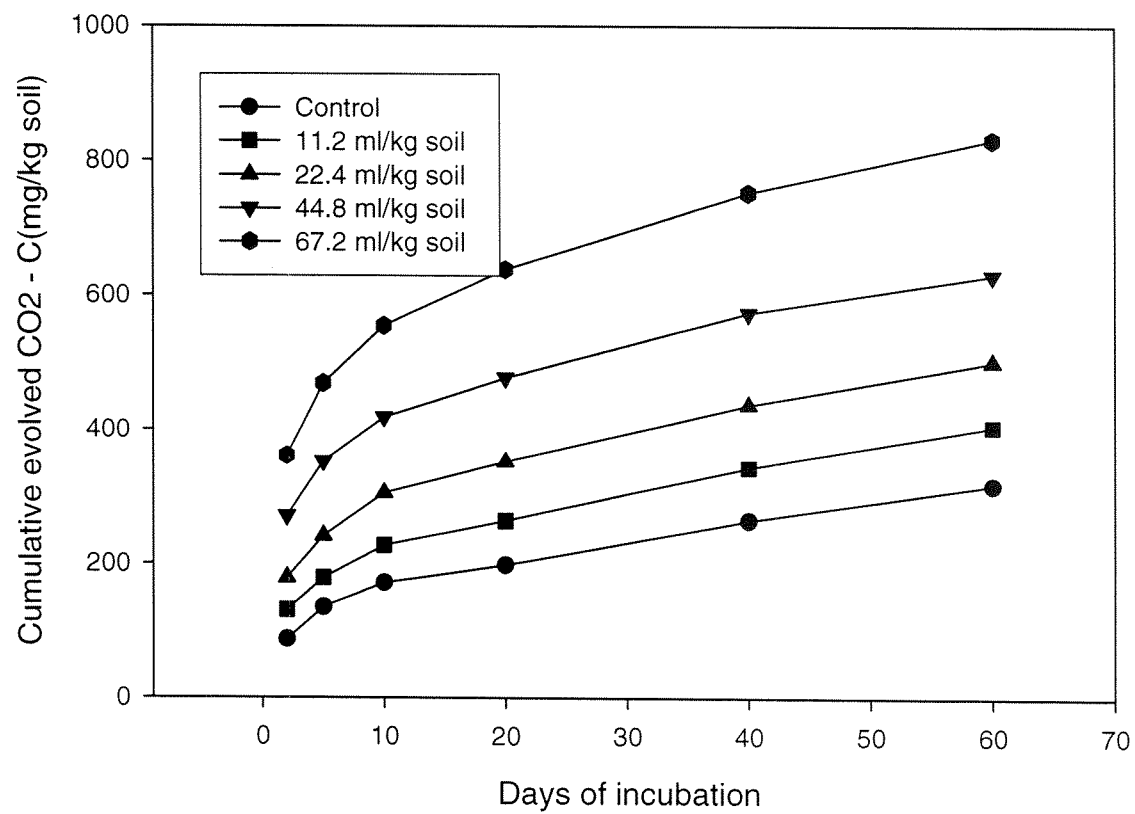


Fig. 8 Cumulative evolved CO₂ as influenced by black liquor application rates

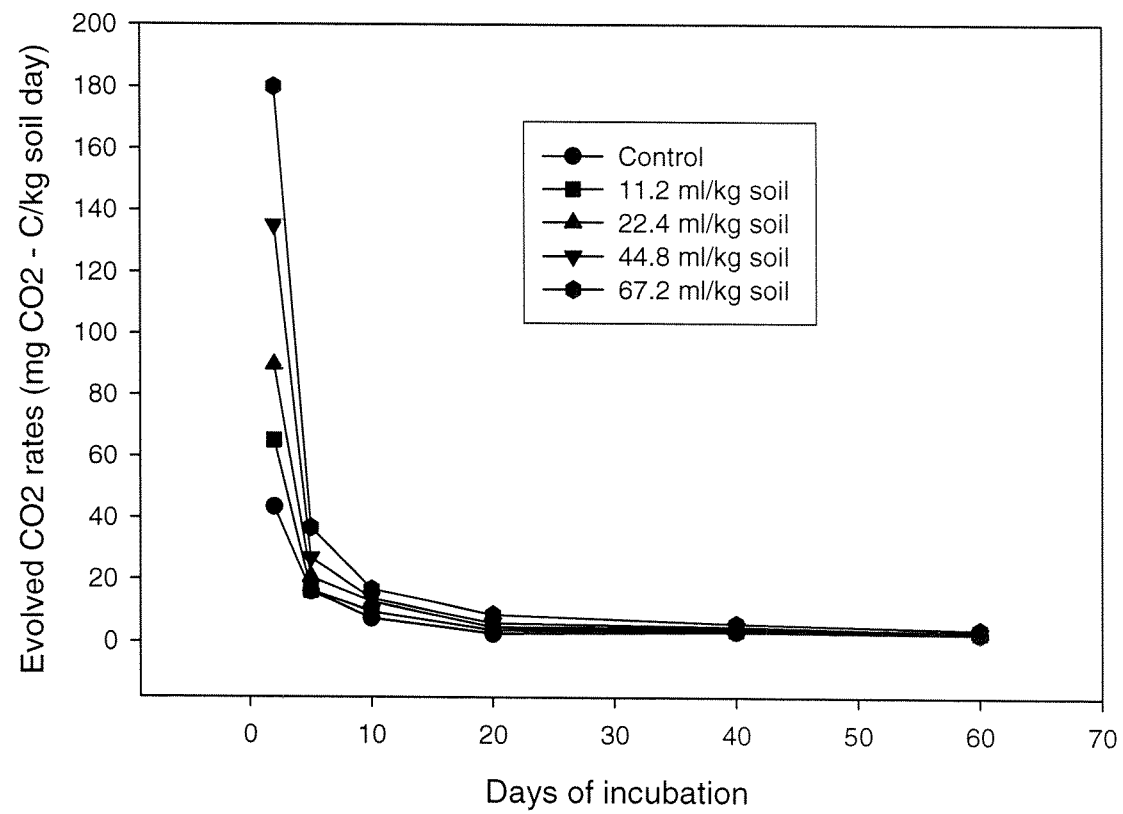


Fig. 9 Evolved CO₂ rates as influenced by black liquor application rates

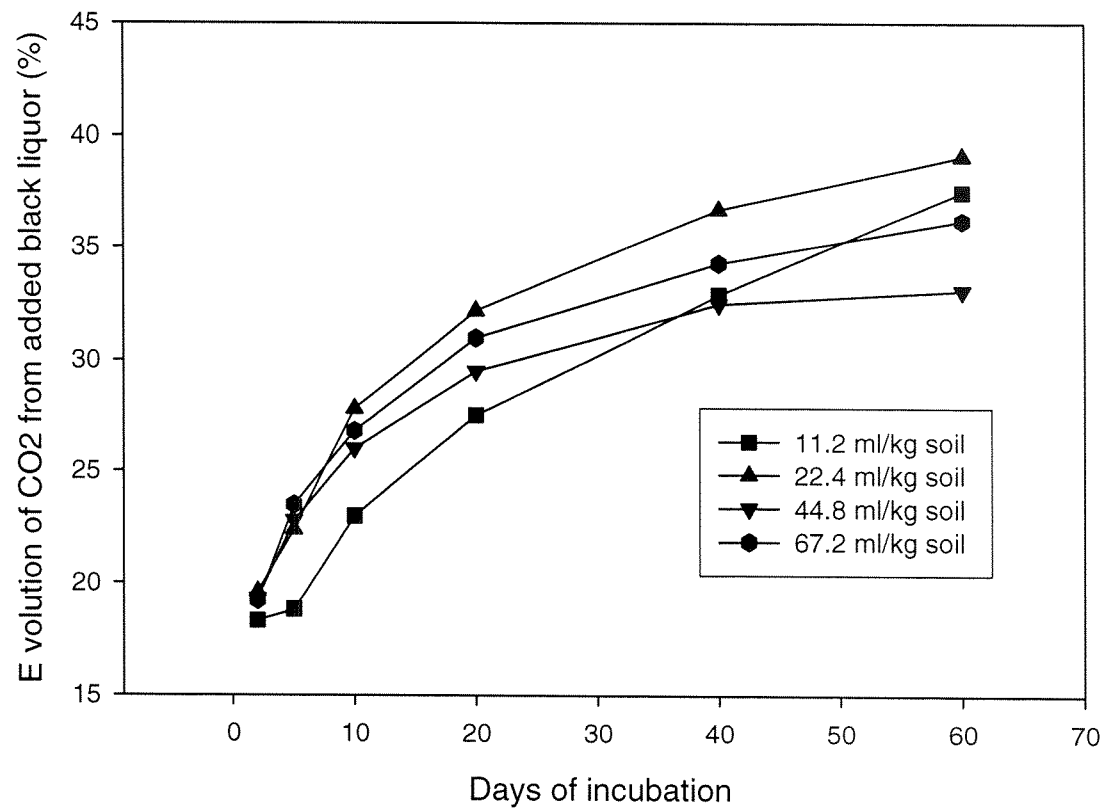


Fig. 10 Percentage of evolution of CO₂ - C from black liquor as influenced by black liquor

Cereal Straw Utilization for Paper

Phase III Report

Pre-commercialization Trial Planning

Michael Jackson

Objective

The objective of Phase III of the study is to evaluate alternative approaches to pilot and pre-commercial testing of agricultural residual for utilization in paper and board products in the Pacific Northwest.

Plans and cost for trials that would produce sufficient quantities of straw pulp for test runs on commercial paper machines and a mill at which these trials potentially could be made are identified.

Trial Criteria

The following criteria must be met:

- **Providing a supply of straw to the mill site**
- **Opening the bales**
- **Removing gross heavy contaminants**
- **Cutting and 'opening' of the straw stalks with destruction of nodes to allow rapid liquor penetration**
- **Removing of fines material (optional but desirable for quality)**

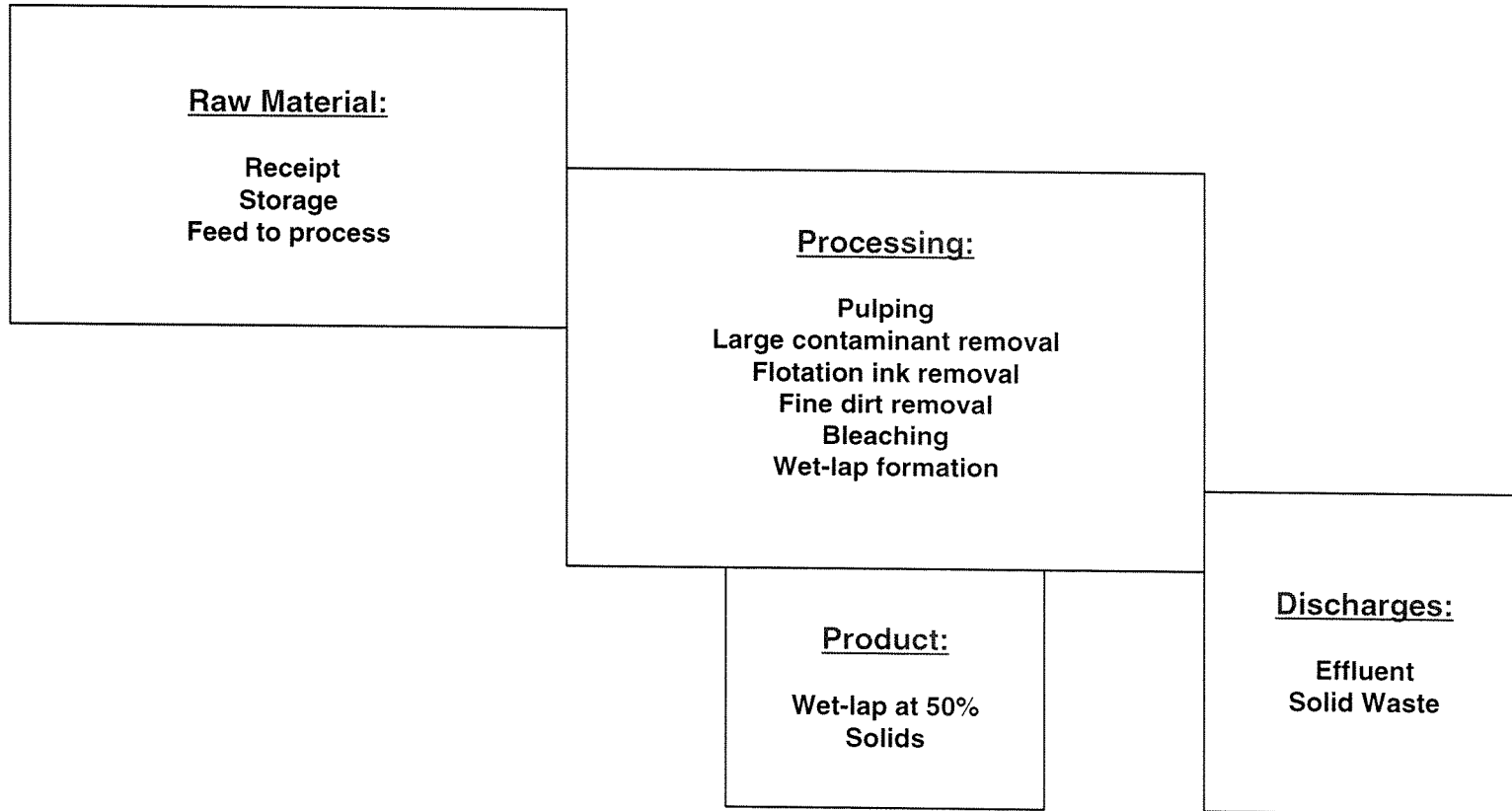
Trial Criteria, continued

- **Cooking the straw at 90-95°C for 45-60 minutes in the presence of sodium (or potassium) hydroxide and other chemicals according to the process conditions specified by the laboratory work**
- **Removing a substantial portion of the spent cooking liquor after the cook and recycling this liquor for treatment of subsequent raw material**
- **Removing some portion of the recycling liquor from the cycle for off-site evaluation**

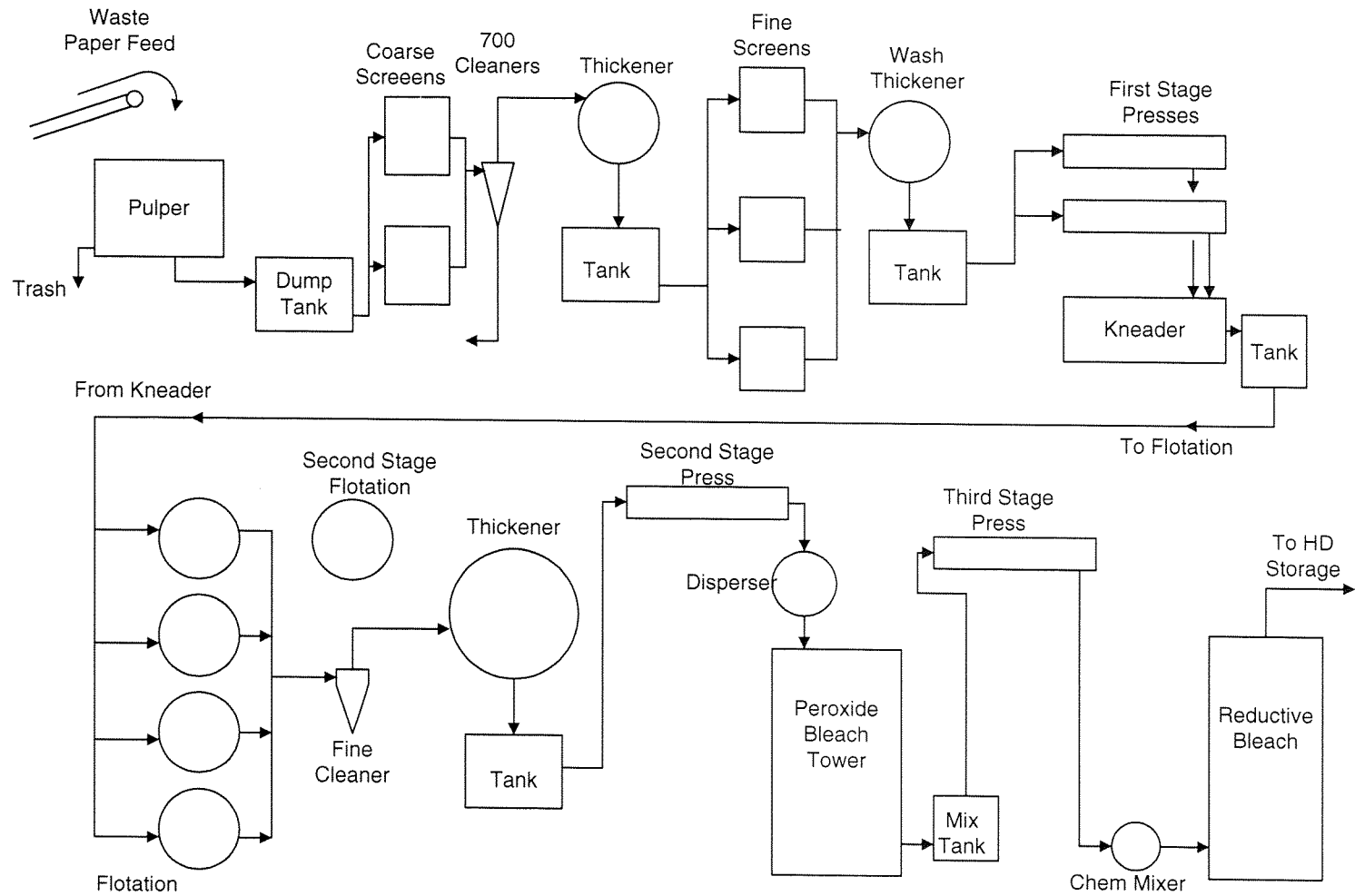
Trial Criteria, continued

- **Washing the cooked pulp after spent liquor separation to reduce entrained dissolved material**
- **Lightly refining to control freeness to a level suitable for board production**
- **Dewatering the refined pulp to a shippable form**
- **Shipping to mills for papermaking trials**

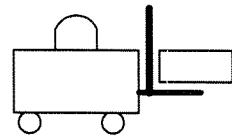
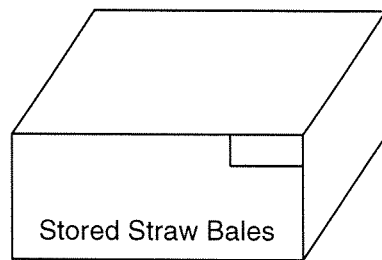
Ponderosa Mill General Layout



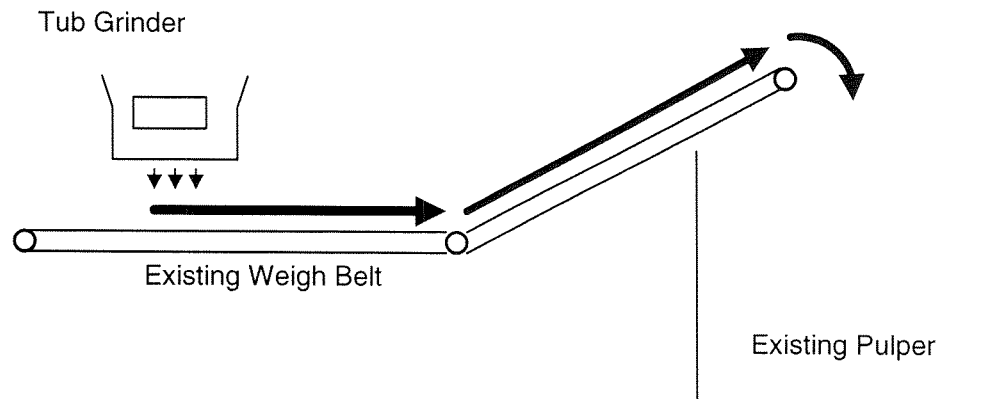
Ponderosa Mill Process Diagram



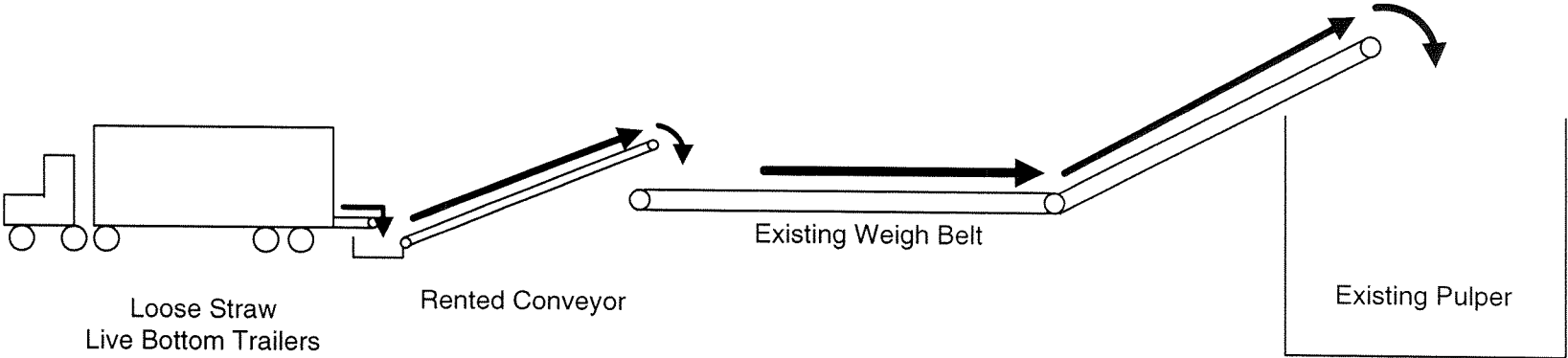
Tub Grinder to Pulper



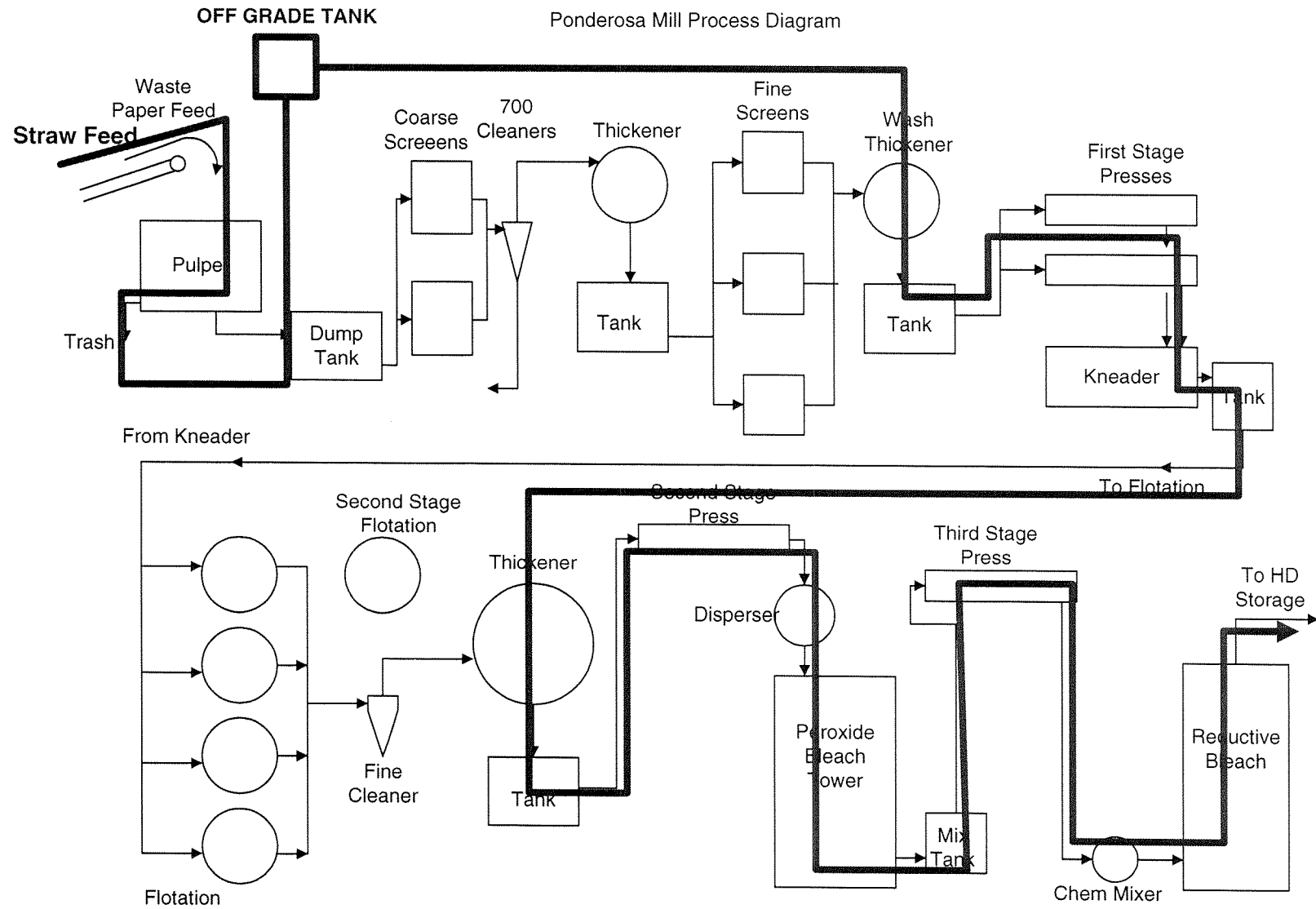
Handled by Fork Lift



Preprocessed Straw to Pulper

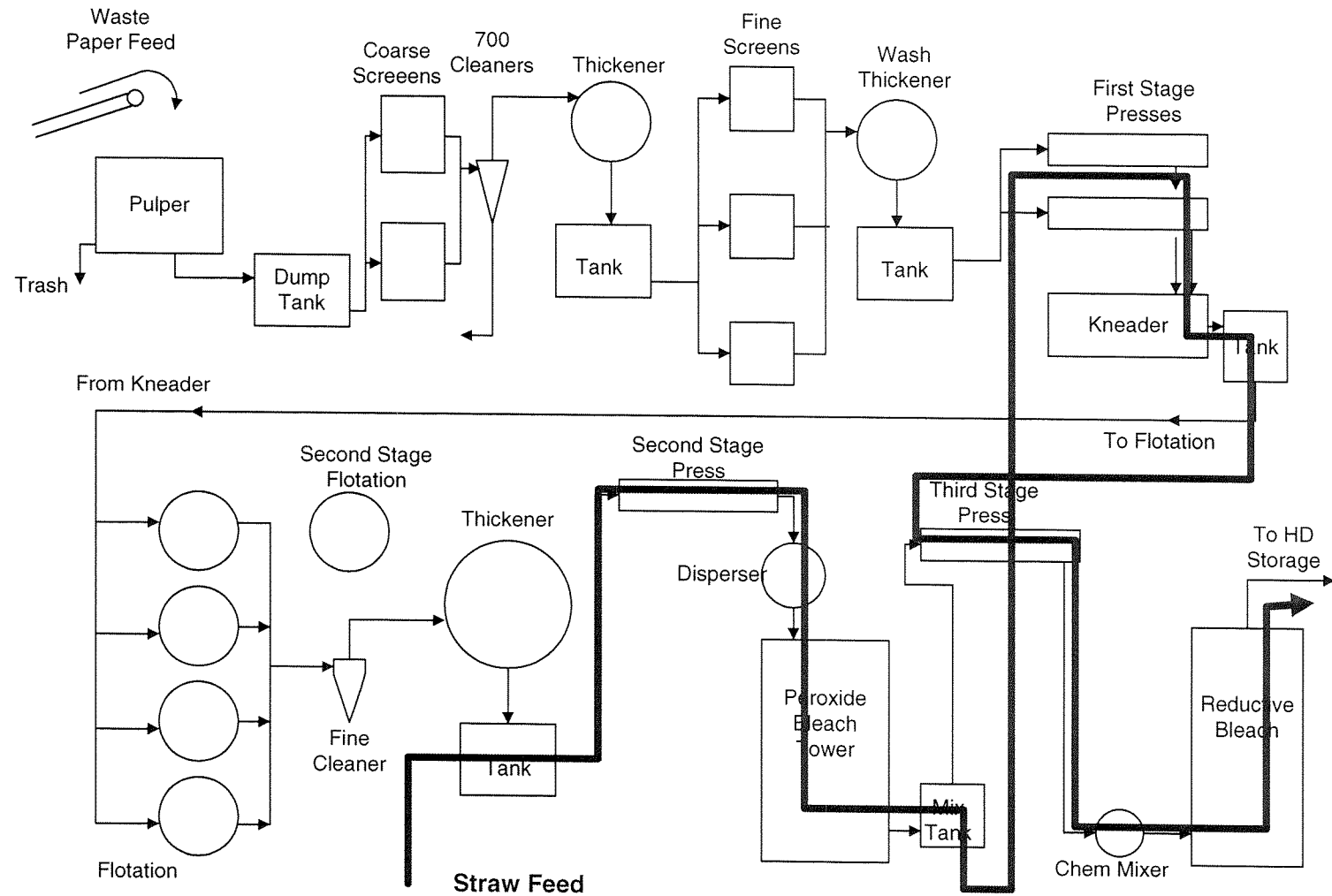


Feed Through Pulper



Feed Through Peroxide Bleach

Ponderosa Mill Process Diagram



Action	By	Month 1	Month 2	Month 3
Source straw		XXXXXXXXXX		
Straw preprocess		XXXXXXXXXX		
Boise specs/cost		XXXX	XXXXX	
Other users				
Identify		XXXX	XXXXXXXXXX	
Agreements			XXXXX	
Contract with mill		XXXX		
ID extra equipment			XXXXXXXXXX	
Approve trial plan				XXXXX
Trial funding			XXXX	XXXXXXXXXX
Set trial conditions and controls			XXXXX	XXXXX

Action	By	Week 1	Week 2	Week 3	Week 4/5
<u>Trial</u>					
Order chemicals		Xx			
Safety review		Xx			
Complete mill mods		Xxxxxxxxxx			
Ship straw to prep		Xxxx			
Preprocessing			xxxxx		
Prep straw to mill			xxxx		
Run trial				xxxx	
Test product				xxx	
Ship product				xxx	
Receive evaluation					xxx
Review mill op					xx
Conclusions					xx

	Amount	Unit Cost	Total Cost
Straw bales delivered	200T	\$50/T	10,000
Tub Grinder rental	14 days	\$250/d	3,500
Bale handling	3 men at 16 hours	\$45.00/hour	2,160
Pulping & processing	20T raw/hour	\$3500/hour	35,000
Shipping	100T	\$50/ as is T	5,000
Preparation work	Manpower-80 hours	\$100/hour	8,000
Process modifications	See Table 4		50,000
Effluent treatment	By Boise Cascade		?
Spent liquor Transportation	One tank truck, 150 miles	\$5.00/ml	750
Off-site testing	40 hours	\$50/hour	2,000
	TOTAL		\$116,410

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